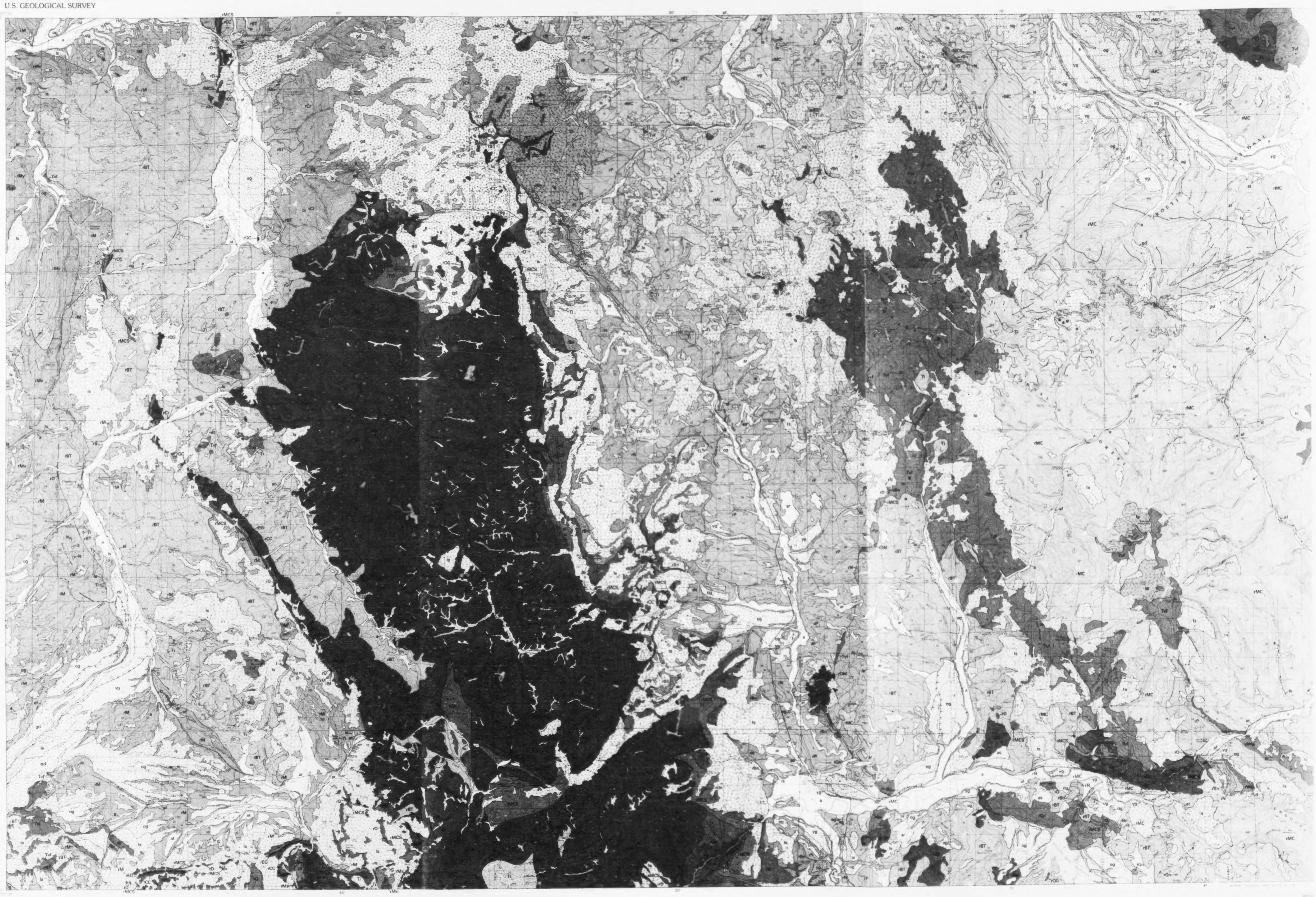
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



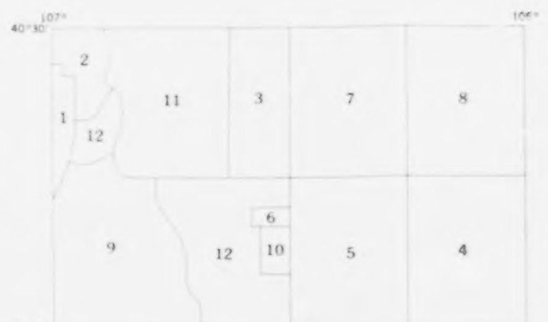
Base from U.S. Geological Survey
County base maps, 1:50,000, Grand, 1978, sheets 1, 2, 3, and 4, Jackson, 1978, sheets 3 and 4, and Routt, 1975, sheets 4 and 5

SCALE 1:100 000

5 MILES

10 KILOMETERS

CONTOUR INTERVAL 80 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



INDEX SHOWING SOURCES OF BEDROCK GEOLOGIC DATA

SOURCES OF BEDROCK GEOLOGIC DATA

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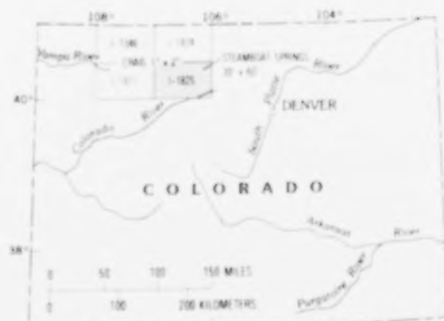
10. Miles, C. H., 1961, Geology of the Pass Creek-Wolford Mountain area, Grand County, Colorado: Golden, Colorado School of Mines, unpublished M.S. thesis, 89 p., pl. 1, scale 1:24,000.
11. Snyder, G. L., 1980, Geologic map of the northernmost Gore Range and southernmost northern Park Range, Grand, Jackson, and Routt Counties, Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map I–1114, scale 1:48,000.
12. Tweto, Ogden, 1976, Geologic map of the Craig 1° × 2° quadrangle, northwestern Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map I–972, scale 1:250,000.



INDEX MAP SHOWING LOCATION OF THE STEAMBOAT SPRINGS 30' × 60' AND CRAIG 1° × 2° QUADRANGLES

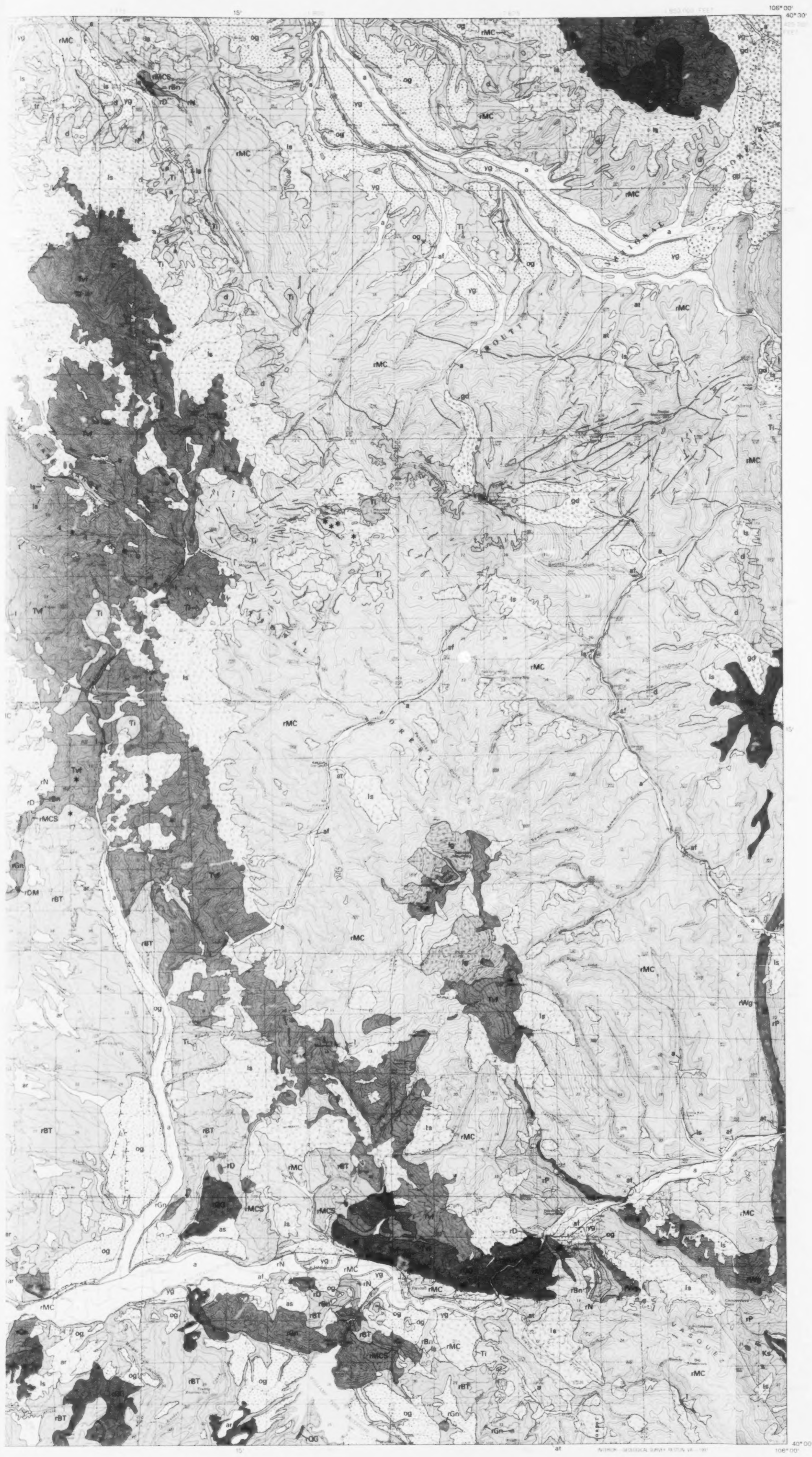
SURFICIAL GEOLOGIC MAP OF THE STEAMBOAT SPRINGS 30' × 60' QUADRANGLE, GRAND, JACKSON, AND ROUTT COUNTIES, COLORADO

By

Richard F. Madole

1991

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–1825

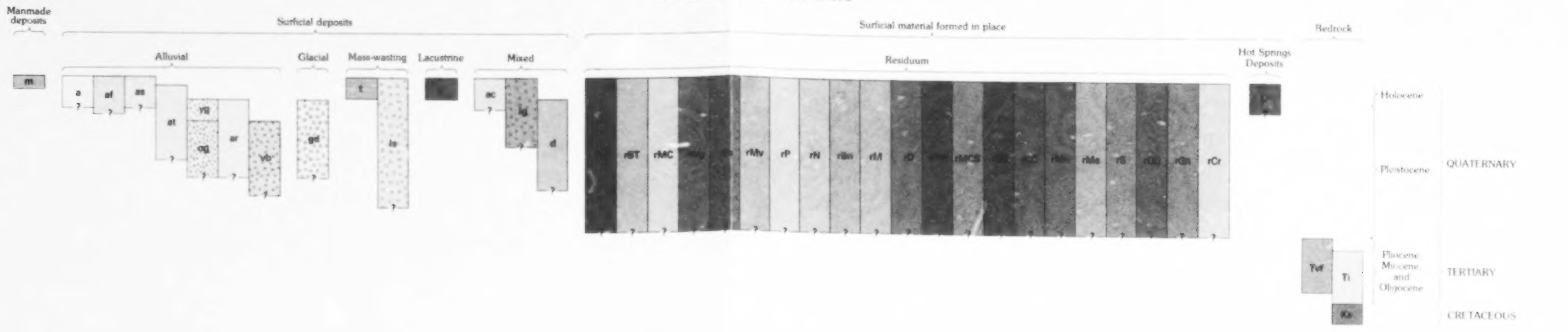


DENVER
COLORADO

INDEX MAP SHOWING LOCATION OF THE STEAMBOAT SPRINGS 30′ × 60′ AND CRAIG 1° × 2° QUADRANGLES

SSON, AND ROUTT COUNTIES, COLORADO

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

This map is one of a series of four 30′ × 60′ surficial geologic maps (1:100,000 scale) intended to provide basic geologic information for planning for energy resource development and growth in northwestern Colorado. An effort is made to characterize all surficial materals, regardless of origin. Hence, residuum is given much more emphasis than is customary, and this results in several departures from conventional practice: bedrock geology is deemphasized; the part of the conventional map symbol denoting geologic age is omitted for surficial units because all surficial units shown are believed to be of Quaternary age; and faults are not shown because none in this map area was observed to displace surficial materials.

Few exposures of most map units exist, except in manmade excavations, such as gravel pits and road cuts. Consequently, thicknesses usually are estimated, and data on stratification, clast size, and relative proportions of matrix and framework clasts are limited to a few localities for each map unit. The Wentworth scale (Wentworth, 1922) is used to describe grain sizes.

Mapping was done chiefly on aerial photographs taken in 1953. Hence, landslides and modifications resulting from gravel mining since 1953 may not show on this map. The scales of the aerial photographs (about 1:60,000) and the map (1:100,000) governed the minimum size of the deposits mapped. The minimum thickness of the deposits mapped is about 1.5 m in most places. Deposit thickness, although not a mapping criterion, influences the topographic expression of many landforms, and landform is the basis for delineating the surficial deposits shown.

MANMADE DEPOSITS

m **Mine dumps**—Chiefly fragmented sandstone and shale stripped from coal beds mined near the western edge of the map area

SURFICIAL DEPOSITS

Alluvial deposits—Clay, silt, sand, and gravel transported and deposited by flowing water in either streams or sheet flow. Alluvium deposited mainly by streams is differentiated, where map scale permits, from that deposited mainly by sheet flow. Stream alluvium is the principal deposit underlying flood plains and stream terraces, and it is the source of most commercial gravel deposits. Sheetwash is present in sheets, wedges, and fans along valley sides; it rarely contains commercial gravel deposits. Gravel is defined as rock fragments that are more or less rounded and are larger than 2 mm in diameter. In the Wentworth scale, this includes granules, pebbles, cobbles, and boulders. Deposits in which gravel is an important constituent are referred to here as either clast-supported gravel or matrix-supported gravel. In a clast-supported gravel, gravel-sized clasts are in clast-to-clast contact throughout most of the deposit, whereas in a matrix-supported gravel, clasts are separated from one another by matrix. Matrix is defined here as the fraction less than 2 mm in size. Deposits of matrix-supported gravel rarely have commercial value

a **Alluvium beneath valley floors (Holocene and upper Pleistocene)**—Sand, silt, gravel, and minor amounts of clay. Along the rivers (Colorado, Illinois, and Yampa Rivers) and larger tributaries, 1–2 m of sand and sandy silt overlie 3–15 m of clast-supported pebble to small-cobble gravel. Most secondary valleys contain 2–7 m of sand, silt, and minor amounts of gravel. Small valleys on the summit of the Gore Range and in the Rabbit Ears Range contain thin deposits of gravel and sand, locally interbedded with or overlain by mud and peat. Clasts in pebble counts at two gravel pits on the floor of the Yampa River near Steamboat Springs (northwestern part of map area) were predominantly granitic rocks (36 and 41 percent), amphibolite (39 and 40 percent), and volcanic rocks (16 and 17 percent). Clasts in alluvium deposited by the Yampa River in the western part of the map area and by Arapaho Creek, Grizzly Creek, and the Illinois River in the north-central and northeastern parts of the map area are mostly volcanic rocks. Gravel along the Colorado River (southeastern part of map area) is composed chiefly of granitic rocks and gneiss. In the narrow, steep-walled valleys of the Gore Range, such as that of Morrison Creek, this unit includes fan and valley-side alluvium, alluvium of low-lying terraces, and minor amounts of sheetwash alluvium (units af, as, and at). The alluvium at the surface of most of the valley floors of the Colorado and Yampa Rivers is believed to be a complex of deposits, 1–3 m thick collectively, of Holocene age. The valley fills underlying the Holocene alluvium are mainly clast-supported gravel of latest Pleistocene age, which is defined here as 10–30 ka

af **Fan and valley-side alluvium (Holocene and upper Pleistocene)**—Sand, silt, and clay interbedded with lesser amounts of gravel. Valley-side alluvium is predominantly fan alluvium deposited at the mouths of gullies and small tributaries, but it also includes sheetwash that is present between fans along the sides of large valleys and the alluvium beneath the valley floors of the small tributaries upstream from the fans. Some alluvial fans are a composite of sheetwash and stream alluvium, and where valley-side slopes are steep, some fans also contain debris-flow deposits and landslide debris. Generally 1–20 m thick

as **Sheetwash alluvium (Holocene and upper Pleistocene)**—Granules, sand, silt, clay, and minor amounts of pebbles and cobbles derived by mass wasting and sheet erosion and deposited by sheet flow on valley-side slopes. This unit is most common in areas of easily eroded detritus, such as that provided by the Miocene Troublesome Formation and the Upper Cretaceous Pierre Shale, in the more arid parts of the map area where vegetation is sparse. The surface of sheetwash alluvium is relatively smooth, having few visible channels, and slopes toward the nearest stream or arroyo. The longitudinal surface profile is concave-upward in most places. The unit locally includes minor amounts of alluvium beneath valley floors and fan and valley-side alluvium (units **a** and **af**). Most of the unit is of Holocene age, but three deposits, located just east of the confluence of the Colorado River and Troublesome Creek (southeastern part of map area), are late Pleistocene, the same age as the stream terraces to which they grade. Generally 1–9 m thick

at **Alluvium of terraces, undifferentiated (Holocene and upper Pleistocene)**—Sand, silt, gravel, and minor amounts of clay. The unit consists mostly of isolated deposits that are present at different terrace levels along secondary streams. These deposits are included in a single unit because correlation of individual levels between drainage basins, as well as the relation of individual levels to main stream terraces, is uncertain in most places. The lowest terrace is generally 2–3 m above stream level and is probably of Holocene age, whereas deposits of the higher levels, generally 10 m to as much as 100 m above stream level, are equivalent in age to the gravel-bearing terrace alluvium deposits (unit **yg** or **og**). In a few places, such as the upper part of the Egeria Creek basin (southwestern map area) and at the head of Muddy Creek (central map area), the alluvium of undifferentiated terraces is found relatively close to older gravel-bearing terrace alluvium (unit og), in the same drainage basin. This distribution resulted because the sediment source for each deposit was different. The older gravel-bearing terrace alluvium in the Egeria Creek basin consists chiefly of outwash deposited when Bear River drained southeast across what is now Five Pine Mesa to the Colorado River. After the Yampa River captured Bear River and diverted the flow northward, alluvium in the Egeria Creek basin was derived primarily from the Cretaceous Mancos Shale, which yields little gravel, and is mapped as alluvium of undifferentiated terraces. At the head of Muddy Creek, this unit also contains little gravel because it was derived mainly from rocks of the Late Cretaceous Pierre Shale and Niobrara Formation. However, this alluvium is present at the same level as gravel-bearing terrace alluvium farther downstream, which was derived by tributaries heading in the Gore and Rabbit Ears Ranges. Generally 1–7 m thick

yg **Younger gravel-bearing terrace alluvium (upper Pleistocene)**—Sand and silt overlying clast-supported pebble to small-cobble gravel containing a few beds and lenses of sand 0.1–1 m thick. These deposits are present along the Colorado, Illinois, and Yampa Rivers, as well as along a few of their larger tributaries. The gravel is commonly 3–15 m thick, and the overlying cover of sandy alluvium is commonly 0.5–1.5 m thick. As much as 10 m of sand and silty sand overlie the gravel locally where fan alluvium and sheetwash from small side valleys were deposited onto or over the former valley floor. Gravel composition is similar to that described for the alluvium beneath valley floors and the older gravel-bearing terrace alluvium (units a and og). Gravel-bearing terrace alluvium deposits are differentiated according to height above stream level, soil development, and weathering of clasts in the B horizon of the soil. The younger gravel-bearing terrace alluvium is of late Pleistocene (10–130 ka) and late middle Pleistocene (130–300 ka) age. In most places, the age of the unit is probably between 130–300 ka, as most gravel of latest Pleistocene age (10–30 ka) is part of the alluvium beneath valley floors (unit **a**). Near the head of the Yampa River, the unit is associated with two terraces about 3 m and 12 m above stream level. Along the Colorado River, the unit is widespread at two levels 10–15 m and 25–30 m above stream level. In the northeastern part of the map area, the unit is present in a distinct terrace 12–16 m above stream level. With the possible exception of Muddy and Troublesome Creeks (central part of map area), the headwater regions of all drainages containing deposits of younger gravel-bearing terrace alluvium were glaciated in Pleistocene time. Most deposits of this alluvium are believed to include outwash and to have been deposited during either the Bull Lake or Pinedale glaciation

og **Older gravel-bearing terrace alluvium (Pleistocene)**—Sand and silt overlying clast-supported pebble to small-cobble gravel containing a few beds and lenses of sand 0.1–1 m thick. The unit is similar to the younger gravel-bearing terrace alluvium (unit **yg**) in distribution, character, and thickness. Loess (not mapped), generally 1–2 m thick, blankets deposits along the Yampa River at and west of Steamboat Springs. The composition of the gravel, determined from pebble counts made at 10 localities along the Yampa River near Steamboat Springs, was 49–54 percent granitic rocks, 35–43 percent amphibolite, 2–7 percent Tertiary volcanic rocks, and gneiss, schist, quartz fragments, and sandstone comprising 1–3 percent each. Granitic clasts also are dominant in the gravel along the Colorado River. Extensive deposits of the unit in the uppermost valley of the Yampa River (southwestern part of map area) are composed almost entirely of volcanic rocks derived from the White River Plateau to the west of the map area. Similarly, the deposits along the Illinois River and Arapaho and Grizzly Creeks are dominated by clasts of volcanic rock. Gravel-bearing terrace alluvium deposits are differentiated according to height above stream level, soil development, and weathering of clasts in the B horizon of the soil. The unit is composed of deposits of middle and early middle Pleistocene age (130–790 ka) and early Pleistocene age (790–1,650 ka). The relation of terrace deposits and loess to glacial deposits along the Yampa River near Steamboat Springs and the ocurrence of the 620,000-yr-old Lava Creek (Izett and Wilcox, 1982) volcanic ash deposits along the Elk River just north of the map area are part of the basis for the middle and early Pleistocene ages assigned to deposits of this unit. Along the Steamboat Springs section of the Yampa River, the unit is associated with seven terrace levels, which are about 10 m, 20 m, 27 m, 37 m, 60 m, 75 m, and 105 m above stream level. In the uppermost part of the drainage basin, near the town of Yampa, the unit is associated with five terraces located 43–50 m, 55–65 m, 145 m, 190 m, and 300 m above stream level. The height above stream level of the upper two levels is questionable, inasmuch as their relation to the present landscape and stream level is not clear. The unit also is present on several terrace levels along the Colorado River and its larger tributaries. The most widespread terrace is 40–50 m above stream level, but smaller terrace remnants also are present at 70–75 m, 100–115 m, and 160–180 m above stream level. Along the Illinois River, the unit is present on two well-defined levels, 15–17 m and 25–28 m above stream level, and it mantles even higher levels north of the map area. With the possible exception of Muddy and Troublesome Creeks, the headwaters of all drainages containing deposits of older gravel-bearing terrace alluvium were glaciated in Pleistocene time, and most of these deposits are believed to include outwash of pre-Bull Lake age

ar **Remnants of stream, sheetwash, and fan alluvium, undifferentiated (Pleistocene)**—Granules, pebbles, cobbles, and boulders in a sandy matrix; sediment less than 4 mm in diameter probably composes the bulk of most deposits. The unit consists of isolated remnants of small paleodrainage systems. Several deposits were related to small drainage systems on the flanks of hills and peaks and include debris-flow deposits. Most deposits are formed on the Troublesome Formation and on the Pierre Shale in the eastern half of the map area. Clasts of Precambrian granitic and gneissic rock tend to dominate in deposits in areas underlain by the Miocene Browns Park and Troublesome Formations, whereas subangular to subrounded pebbles, cobbles, and boulders of volcanic rock are dominant in the topographically conspicuous deposits overlying the Pierre Shale in the upper part of the Muddy Creek drainage basin. Generally 2–10 m thick

vb **Volcanic-boulder gravel (Pleistocene)**—Subangular to subrounded volcanic pebbles, cobbles, and boulders plus subordinate amounts of nonvolcanic clasts in a sandy matrix. The unit is present only on Woodchuck Hill in the west-central part of the map area. The unit underlies relatively smooth, graded surfaces that slope steeply from the summit of Woodchuck Hill, which is capped by volcanic rocks. The form of the deposits suggests a fluvial origin, but the unit may also contain debris-flow and landslide deposits. The deposits apparently accumulated in the channels of small valleys on the flanks of Woodchuck Hill, which is underlain by the Browns Park Formation. In time, the valley fills became prominent benches because rocks of the Browns Park Formation are more easily eroded than the volcanic-boulder gravel. Unit is 5–15 m thick

Eolian deposits—Sand, silt, and clay deposited by wind. Loess (windblown silt) is widespread, but is not shown on this map because it lacks topographic expression and could be mapped only with detailed fieldwork. Loess representing two episodes of deposition is present along the valleys of the Yampa and Elk Rivers in the northwestern corner of the map area. Deposits of both episodes are present in most exposures. The thickness of each loess deposit varies, but the total for both commonly is only 1.3–2.0 m. Typically, 0.5–0.8 m of brown loess (usually 10*YR* 4/3, 6/3, or 6/4 when dry, "Munsell Soil Color Chart") overlies 0.8–1.3 m of reddish-yellow to strong-brown loess (usually 7.5*YR* 5/6, 6/6, or 6/4 when dry) that commonly contains mottles or veinlets of $CaCO_3$. Stratigraphic relations with moraines and stream-terrace deposits, some of which are outside the map area, suggest that deposition of the younger loess occurred in latest Pleistocene time and possibly continued into Holocene time, whereas deposition of the older loess occurred mainly in middle Pleistocene time

Glacial deposits—Very poorly sorted, unstratified deposits of large clasts in a fine-grained matrix; contain minor amounts of stratified drift, especially near the lower limit of glaciation

gd **Glacial deposits (upper Pleistocene)**—Subangular to subrounded boulders, cobbles, and pebbles in a sandy matrix. Till is commonly 75–85 percent material less than 2 mm in size, and associated deposits of stratified drift are commonly 75–85 percent material coarser than 2 mm. The matrix is predominantly coarse sand where source rocks were Precambrian crystalline rocks (northern part of the map area), but is finer grained where source rocks included Mesozoic and Cenozoic sedimentary rocks (southwestern part of the map area). Most of the unit is till of Pinedale age, but deposits of Bull Lake and pre-Bull Lake age are included also. Unit is probably 1–5 m thick in most places, but may be as thick as 30 m in lateral and end moraines

Mass-wasting deposits—Debris transported downslope primarily by gravity and not within or under another medium, such as water or ice

t **Talus deposits (Holocene)**—Accumulations of angular rock debris ranging in size from sand to boulders more than 1 m long on or at the base of steep slopes, derived chiefly by falling, rolling, and sliding. Some talus deposits are the result of landsliding and (or) include landslide deposits. Small talus deposits within landslides generally are not differentiated from the landslide deposits (unit ls). The unit includes a few protalus-rampart and rock-glacier deposits too small and (or) ill-defined to warrant showing separately. Generally 1–30 m thick

ls **Landslide deposits (Holocene and Pleistocene)**—Heterogeneous mixture of unconsolidated surficial material and rock debris in a wide range of sizes. The size and kind of clasts and the grain-size distribution of the matrix vary according to the bedrock units involved in the slide. Most of the landslides were complex (Varnes, 1978), and the dominant types of movement were rotational slides (slump) and earth flow. The unit includes areas of bedrock exposed in slide paths and in scarps at the heads of slides. Landslide scars (mainly headwall scarps) tend to survive as landforms long after the slide toe or deposit has been removed or obscured by erosion. The form of landslide deposits in weakly indurated rocks, such as those from which unit rBT is derived, becomes obscure more rapidly than that of landslides composed of fragments of coherent rock. The unit includes landslide scars only where the associated slide deposit can be recognized. Landslides are particularly extensive in areas underlain by the Mancos Shale and its equivalents east of the Gore Range (Pierre Shale, Niobrara Formation, and Benton Shale). They are also widespread along steep slopes capped by resistant volcanic rocks in the southwestern corner of the map area (eastern edge of the White River Plateau), the eastern part of the map area (Rabbit Ears Range), and at the northeastern corner of the map area (Owl Mountain). The unit locally includes talus deposits, pond deposits, and small areas of glacial deposits along the north and northeast flanks of Arapaho Ridge (northeastern part of map area)

Lacustrine deposits—Sediment deposited in small lakes dammed by landslides

l **Lake deposits (Holocene)**—Gravel, sand, silt, clay, and minor amounts of peaty sediment. The few deposits of this unit that are large enough to be mapped are in landslide-dammed valleys in the Rabbit Ears Range (eastern part of the map area) and in the southeastern corner of the map area. Unit is probably 1–20 m thick

Mixed deposits—Two or more deposits of different origins mapped as a single unit because identification of origin is uncertain or because boundaries are indistinct or broadly gradational

ac **Alluvium and colluvium in paleovalleys (Holocene and Pleistocene)**—Granules, sand, silt, clay, and scattered subangular to subrounded pebbles, cobbles, and a few boulders, derived mostly from Precambrian crystalline rock. Much of the unit is thought to be associated with a paleodrainage system that was developed on an erosion surface cut on the Precambrian rocks that form the core of the Gore Range. This erosion surface formed mainly in the time between deposition of the Middle Park Formation (Upper Cretaceous(?) and Paleocene) and deposition of the Browns Park and Troublesome Formations (Miocene). Most deposits of the unit are probably 1–20 m thick

lg **Landslide and glacial deposits, undifferentiated (Holocene and upper Pleistocene)**—These deposits were mapped as a single unit because their distribution is complex and they are difficult to distinguish separately over much of the area. Commonly, landslides, till, and landslides that include till are juxtaposed. Most of the unit is probably 1–50 m thick

d **Diamicton (Pleistocene)**—Angular to subrounded boulders, cobbles, and pebbles in a sandy matrix. Diamicton, a nongenetic term for poorly sorted terrestrial sediment, is used here for bouldery deposits whose origin is uncertain. In most cases, the uncertainty derives from the lack of associated landforms or exposures of diagnostic sedimentary structures that permit recognition of deposit genesis. Most deposits are in the northeastern part of the map area, on the northeastern part of Arapaho Ridge, on the flanks of Owl Mountain, and on interfluves on the lower slopes of Gravel Mountain. Most deposits are probably of a glacial or mass movement origin, but some, such as those on the lower slopes of Little Gravel Mountain, may be fluvial. Unit is 1–10 m thick in most places

SURFICIAL MATERIAL FORMED IN PLACE

Residuum—Unconsolidated material essentially formed in place by disintegration and decomposition of underlying bedrock. Each residuum unit includes colluvium and bedrock outcrops in varying amounts, as differentiation of these materials is not practical at the map scale. Residuum and colluvium are probably equally ubiquitous over much of the map area, and statements about the relative proportions of each are interpretive at best because exposures of them are limited to a few areas. The deposits are physically similar in most places, and unless slopes are steep, colluvium may be merely residuum that has moved a short distance downslope under the influence of gravity. Contacts between residuum units were made to correspond to contacts between bedrock units in order to provide information about bedrock geology and to relate surficial materials to their bedrock sources. In the case of heterogeneous bedrock units, this practice has the disadvantage of including residuum of dissimilar characteristics in the same map unit. However, a more detailed characterization of residuum derived from heterogeneous bedrock formations is impractical at the map scale. The lower contact of residuum is more difficult to define than that of transported surficial units because residuum is gradational to partially weathered bedrock. In a sense, the age of residuum also may be gradational: weathering continuously produces residuum from bedrock below the surface, while erosion continuously removes residuum at the surface. On this map, all residuum is assigned a Quaternary age. Remnants of Tertiary landscapes are believed to be rare. Even deposits as young as those that contain the middle Pleistocene Lava Creek volcanic ash (620 ka according to Izett and Wilcox, 1982) are of very limited areal extent. Residuum is generally 1–2 m thick on gentle to moderate slopes (0–25 percent grade, 0–14°). On slopes steeper than 25 percent (14°), residuum is commonly less than 1 m thick, although accumulations of colluvium thicker than 1 m may be present in swales on steep slopes. Residuum thicker than 2 m is restricted largely to areas underlain by poorly consolidated bedrock units, such as the Browns Park and Troublesome Formations. Steep slope, as used in the description of residuum, is defined as being greater than 25 percent (14°)

rBg **Residuum on boulder gravel (Holocene and Pleistocene)**—Subrounded to rounded granules, pebbles, cobbles, boulders as long as 3 m, and matrix composed predominantly of sand. Most clasts are crystalline rocks of Precambrian age. The parent rock of most of the unit in the western part of the map area was mapped initially by Snyder (1980) as pebble alluvial conglomerate of undifferentiated Browns Park (Miocene) to Coalmont (Eocene and Paleocene) age. One deposit, in the vicinity of Rabbit Ears Peak, was mapped by Scott (1961) as Browns Park (?), by Hail (1968) as Coalmont, and by Snyder (1980) as post-Coalmont and pre-Browns Park. Near the east edge of the map area, unit **rBg** was derived from unconsolidated boulder conglomerate considered to be Pliocene (?) by Izett (1968). Residuum grades downward to unconsolidated boulder gravel that is as much as 213 m thick (Snyder, 1980)

rBT **Residuum on Browns Park and Troublesome Formations (Holocene and Pleistocene)**—Sand, silt, and subordinate amounts of clay and gravel. Near the margins of uplands of Precambrian rock, the unit contains boulders as long as 1–2 m. The gravel is mostly crystalline Precambrian rock. In a few places, as along Oak Creek, about 11 km southwest of Steamboat Springs, the unit resembles till because it contains abundant large boulders. On Green Ridge (southwestern part of the map area), the unit includes thin deposits of fluvial origin, probably mostly sheetwash, composed of pebbles, cobbles, and boulders of Precambrian granitic and metamorphic rock in a sandy matrix. These deposits appear to be associated with surfaces cut on the Browns Park Formation; however, the deposits are not distinct enough and sufficiently persistent to be mapped as alluvial remnants (unit **ar**), as are similar deposits in other parts of the map area underlain by the Browns Park and Troublesome Formations. On the summit of the Gore Range, the unit includes small deposits of alluvium beneath valley floors and sheetwash alluvium (units **a** and **as**). The unit is commonly 1–3 m thick, but may be less than 1 m thick on steep slopes. Grades downward to sandstone and siltstone, some tuffaceous, of the Browns Park and Troublesome Formations (Miocene). Locally includes small areas of bedrock

rMC **Residuum on Middle Park and Coalmont Formations (Holocene and Pleistocene)**—Gravel, boulders locally (eastern edge of map area), sand, silt, and clay. Clasts in this unit are chiefly Precambrian crystalline rock. Commonly 1–2 m thick, but is less than 1 m thick on steep slopes. Grades downward mainly to conglomerate and sandstone of the Middle Park Formation (Upper Cretaceous(?) and Paleocene) in the southeastern part of the map area and to sandstone and shale of the Coalmont Formation (Paleocene and Eocene) in the northeastern and north-central parts of the map area. The strata of the Middle Park and Coalmont Formations are largely equivalent, but the name Coalmont is used north of the Continental Divide, which trends approximately east-west in this part of the map area, and the name Middle Park is used south of the divide. Residuum derived from a fragmental andesitic and trachyandesitic volcanic rock of the Upper Cretaceous(?) Windy Gap Volcanic Member of the Middle Park Formation (Izett, 1968) is shown separately. Locally includes extensive areas of bedrock, especially on steep valley sides in southeastern part of the map area

rWg **Residuum on the Windy Gap Volcanic Member of the Middle Park Formation (Holocene and Pleistocene)**—Gravel, sand, silt, and clay. Mainly angular to subrounded clasts of volcanic rock and a small percentage of clasts of Precambrian rock in a predominantly sandy matrix. Unit is as much as 1–2 m thick, but is less than 1 m thick on steep slopes. Grades downward to volcanic breccia of porphyritic andesite and trachyandesite interbedded with volcanic conglomerate, sandstone, and siltstone (Izett, 1968). Locally includes extensive areas of bedrock

[illegible] **Residuum on Lewis Shale (Holocene and Pleistocene)**—Dark-gray to grayish-brown clay, silt, and subordinate amounts of sand. Unit is present only at the west edge of the map area. Generally 1–2.5 m thick, but may be less than 1 m thick on steep slopes. Grades downward to weathered Lewis Shale (Upper Cretaceous). Locally includes small areas of bedrock. The Lewis Shale and the clayey residuum formed from it are particularly prone to landsliding, and they may also produce high swelling pressures

rMv **Residuum on the Mesaverde Group (Holocene and Pleistocene)**—Sand, silt, clay, and, in places, sandstone clasts ranging in size from pebbles to boulders. The residuum reflects variations in bedrock that consists of alternating sandstone and shale. The residuum derived from shale is clayey and that derived from sandstone is sandier and typically more stony. Bouldery colluvium several meters thick, containing clasts as large as 3 m in maximum dimension, commonly mantles slopes below sandstone ledges. Generally 1–2 m thick, but is less than 1 m thick on steep slopes and valley sides. Grades downward to weathered shale and sandstone of the Mesaverde Group (Upper Cretaceous). Locally includes extensive areas of bedrock, particularly on steep valley sides. Shale in the Mesaverde Group and residuum derived from shale may produce high swelling pressures

rP **Residuum on Pierre Shale (Holocene and Pleistocene)**—Silt, clay, sand, and minor amounts of gravel-sized rock fragments. The residuum reflects variations in bedrock. Near its western limit, the unit is derived chiefly from shale and is clayey, but farther east it is derived from interbedded silty and sandy shale, shaly sandstone, and sandstone and is correspondingly sandier. Generally 1–3 m thick, but is less than 1 m thick on steep slopes. Grades downward to weathered shale or sandstone of the Pierre Shale (Upper Cretaceous). The unit is mapped east of the Gore Range only. West of the Gore Range, its equivalent is included mostly in residuum on Mancos Shale (unit **rM**). Locally includes areas of bedrock. The Pierre Shale and residuum derived from it are particularly susceptible to landsliding, and they may also produce high swelling pressures

rN **Residuum on Niobrara Formation (Holocene and Pleistocene)**—Silt, clay, and subordinate amounts of sand and pebble-sized chips of limestone and limy shale. Generally 1–3 m thick, but is less than 1 m thick on steep slopes. Grades downward to weathered, light-gray to gray, calcareous shale or shaly limestone of the Niobrara Formation (Upper Cretaceous). This unit is mapped east of the Gore Range only. West of the Gore Range, its equivalent is included with residuum on Mancos Shale (unit **rM**). Locally includes areas of bedrock

rBn **Residuum on Benton Shale (Holocene and Pleistocene)**—Silt, clay, and subordinate amounts of sand and gravel-sized rock fragments. Generally 1–3 m thick, but is less than 1 m thick on steep slopes. Grades downward in most places to gray to black Benton Shale (Upper and Lower Cretaceous). This unit is mapped east of the Gore Range only. West of the range, its equivalent is included with residuum on Mancos Shale (unit **rM**). Locally includes small areas of bedrock. The Benton Shale contains a few seams of bentonite, and the clayey residuum derived from the Benton Shale may produce high swelling pressures

rM **Residuum on Mancos Shale (Holocene and Pleistocene)**—Gray clay, silt, and subordinate amounts of sand. In places, 5–10 percent of the residuum consists of chips of sandstone, most of which are 2–5 cm long. Generally 1–2 m thick, but may be less than 1 m thick on steep slopes. Grades downward to Mancos Shale (Upper and Lower Cretaceous). This unit is mapped west of the Gore Range only. East of the Gore Range, equivalents of this unit are included in residuum on Benton Shale, Niobrara Formation, and Pierre Shale (units **rBn**, **rN**, and **rP**). Locally includes small areas of bedrock. The Mancos Shale and the clayey residuum formed from it are susceptible to landsliding, and they also may produce high swelling pressures

rD **Residuum on Dakota Sandstone (Holocene and Pleistocene)**—Sand, silt, clay, and variable amounts of sandstone clasts ranging in size from pebbles to boulders. The residuum reflects variations in bedrock, which is chiefly sandstone, but also includes shale. The residuum derived from sandstone is sandy and stony, whereas that derived from shale is clayey. Generally 1–2 m thick, but is less than 1 m thick on steep slopes. Grades downward to sandstone, siltstone, and shale of the Dakota Sandstone (Lower Cretaceous). Locally includes extensive areas of bedrock

[illegible] **Residuum on Dakota Sandstone and Morrison and Sundance Formations, undifferentiated (Holocene and Pleistocene)**—Sand, silt, clay, and small amounts of gravel-sized clasts. Unit is mapped only near Kremmling along a zone of complex geology associated with the Williams Range thrust fault (not shown on this map). The residuum reflects variations in bedrock, which consists chiefly of sandstone, shale, and mudstone. The residuum derived from shale and mudstone is clayey, whereas that derived from sandstone is sandier and more stony. Generally 1–2 m thick, but is less than 1 m thick on steep slopes. Grades downward to weathered rocks of the Dakota Sandstone (Cretaceous) and Morrison and Sundance Formations (Jurassic). Locally includes areas of bedrock

rMCS **Residuum on Morrison, Curtis, and Sundance Formations, undifferentiated (Holocene and Pleistocene)**—Clay, silt, sand, and small amounts of gravel-sized clasts. The residuum reflects variations in bedrock, which consists chiefly of mudstone, limestone, and sandstone. It is clayey over most of the area where derived from the Morrison and Curtis Formations (Jurassic) and sandy where derived from the Sundance Formation (Jurassic). Generally 1–2 m thick, but may be less than 1 m thick on steep slopes. Grades downward to mudstone, limestone, sandstone, and siltstone of the Morrison and Curtis Formations and to gray, reddish-brown, yellowish-brown, and pink sandstones of the Sundance Formation. Locally includes areas of bedrock

[illegible] **Residuum on Entrada and Glen Canyon Sandstones (Holocene and Pleistocene)**—Sand, silt, and small amounts of clay and gravel-sized clasts. Generally 1–2 m thick, but may be less than 1 m thick on steep slopes. Grades downward into sandstone of the Entrada (Jurassic) and Glen Canyon Sandstones (Triassic). Locally includes areas of bedrock

rCC **Residuum on Chinle, Chugwater, and State Bridge Formations (Holocene and Pleistocene)**—Sand, silt, clay, and minor amounts of gravel-sized clasts. The residuum reflects variations in bedrock that consists chiefly of red shale, siltstone, and sandstone interbedded with minor amounts of limestone, conglomeratic sandstone, and conglomerate. The residuum is mostly sandy or clayey silt where derived from siltstone and limestone, is pebbly, silty sand where derived from sandstone, and is markedly clayey where derived from shale. Generally 1–3 m thick, but may be less than 1 m thick on steep slopes. Grades downward to mostly red beds of the Chinle and Chugwater Formations (Triassic) and State Bridge Formation (Lower Triassic and Permian). Locally includes small areas of bedrock

rMn **Residuum on the Minturn Formation (Holocene and Pleistocene)**—Pebbles, granules, sand, silt, and lesser amounts of clay. The residuum reflects variations in bedrock that consists chiefly of arkose and conglomerate interbedded with shale, thin sandstone and limestone, and mudstone. Residuum derived from arkose, conglomerate, and sandstone is mostly gravelly sand, whereas that derived from shale, mudstone, and limestone is mostly clayey silt. Generally 1–3 m thick, but may be less than 1 m thick on steep slopes. Grades downward to weathered bedrock of the Minturn Formation (Pennsylvanian). Locally includes areas of bedrock

rMs **Residuum on rocks of Mississippian age, undifferentiated (Holocene and Pleistocene)**—Sand, silt, clay, and minor amounts of gravel-sized clasts of chert and carbonate rocks. The residuum is derived from limestone and dolomite. Generally 1 m thick or less. Grades downward into weathered rocks of the Leadville Limestone (Mississippian) and Dyer Dolomite (Mississippian(?) and Devonian) of the Chaffee Group. Locally includes areas of bedrock

rЄ **Residuum on the Sawatch Quartzite (Holocene and Pleistocene)**—Gravel, sand, silt, and clay. The residuum is sandy in most places, but is locally clayey where derived from shales that occur near the base of the parent bedrock unit. Generally 1–2 m thick, but may be less than 1 m thick on steep slopes. Grades downward to mostly sandstone, conglomeratic sandstone, and conglomerate of the Sawatch Quartzite (Cambrian). Locally includes areas of bedrock

[illegible] **Residuum on quartz monzonite, gneissic granite, and granodiorite (Holocene and Pleistocene)**—Granules and sand plus subordinate amounts of silt, clay, and subangular to subrounded clasts, which range in size from pebbles to boulders, most less than 50 cm in maximum dimension. Generally less than 1 m thick. Grades downward in most places to weathered quartz monzonite, gneissic granite, and granodiorite (Early Proterozoic). Includes extensive areas of bedrock

rGn **Residuum on gneiss (Holocene and Pleistocene)**—Granules, sand, subordinate amounts of silt and clay, and abundant angular to subangular clasts, which are chiefly biotite gneiss and range in size from pebbles to boulders, most less than 50 cm in maximum dimension. Generally less than 1 m thick. Grades downward to weathered gneiss (Early Proterozoic). Includes extensive areas of bedrock

rCr **Residuum on Precambrian crystalline rocks, undifferentiated (Holocene and Pleistocene)**—Granules, sand, silt, subordinate clay, and angular to subrounded clasts that are chiefly schist, gneiss, amphibolite, and granitic rock and range in size from pebbles to boulders, most less than 50 cm in maximum dimension. Generally less than 1 m thick. Grades downward to weathered quartz monzonite, granite, granodiorite, biotite and hornblende gneiss, amphibolite, schist, and locally to gabbro, diorite, and marble (Middle and Early Proterozoic). Includes extensive areas of bedrock

Hot springs deposits—Rock chemically precipitated from the water of hot springs

[illegible] **Travertine (Holocene and upper Pleistocene)**—Gray, dense $CaCO_3$ precipitated from hot springs associated with a large fault (not shown on this map) on the west flank of the Park Range (northern continuation of the Gore Range) at Steamboat Springs

BEDROCK

Igneous rocks—Shown as bedrock rather than residuum because most exposures are mainly bare rock. Only the larger remnants of volcanic flows are overlain by extensive unconsolidated detritus. The detritus, however, is thin and much is of mixed origin (residuum, colluvium, and deposits derived by eolian and periglacial processes); hence, the detritus is not mapped separately

Tvf **Volcanic flows and other volcanic rocks (Pliocene, Miocene, and Oligocene)**—Mostly trachyandesite to basaltic flows and tuff breccia. Includes scoria agglomerate and conglomerate (Snyder, 1980) in the southwestern part of the map area. Both the Rabbit Ears Volcanics (Miocene(?) and Oligocene), which are mostly tuff breccia, and the Grouse Mountain Basalt (Miocene) of Izett (1968) and Izett and Barclay (1973) are included in this unit

Ti **Intrusive igneous rocks (Miocene and Oligocene)**—Mostly shallow rhyodacite to basalt intrusions consisting of plugs, sills, and dikes. Includes small exposures of latite porphyry (Kucera, 1962) at the south edge of the map area, southeast of Toponas

Ks **Syenite (Cretaceous)**—Gray, fine-grained, porphyritic augite syenite occurring in dikes and plugs (Izett, 1968). Unit is found only in the southeastern part of the map area

Contact

Fracture—Probably related to landsliding

Stream-terrace scarp—Separates contiguous terrace deposits of the same map unit; tick marks are on side of lower terrace

Dike or sill (Miocene and Oligocene)—Rhyodacite to basalt in composition

Crest of lateral or end moraine

✱ **Small landslide deposit**

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